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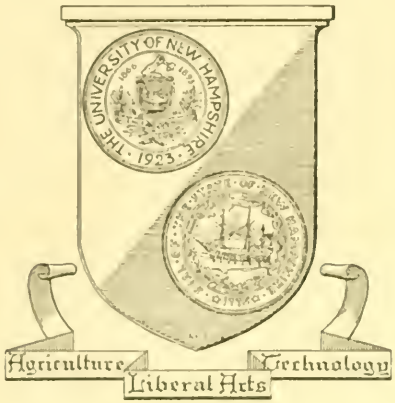

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Farm Organization and Management

IN THE

Colebrook Area

by

HARRY C. WOODWORTH

and

ARNO HANGAS

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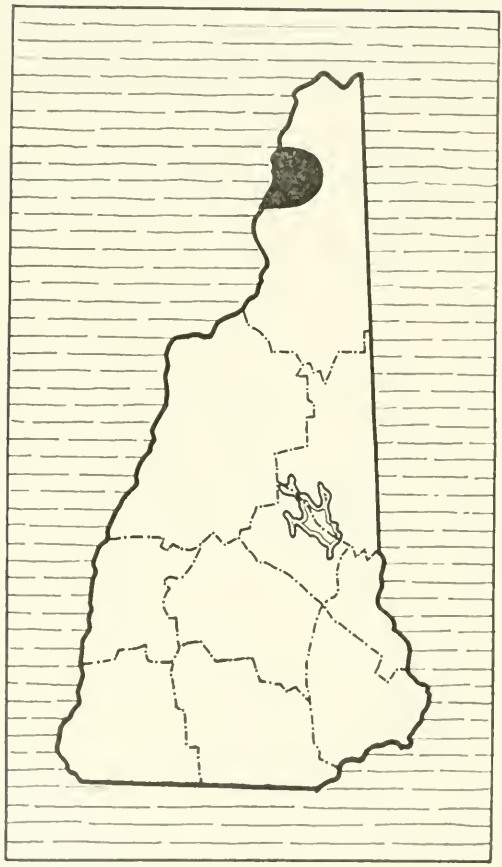

FIGURE 1. Map of New Hampshire showing location of the area studied.

Farm Organization and Management in the Colebrook Area

By Harry C. Woodworth and Arno Hangas

THIS PROJECT was initiated in 1933 to study the management problems of farms in the Colebrook area, particularly to study the efficiency with which major enterprises were handled on individual farms, to note the effect of the various combinations of enterprises on income, and to suggest and check combinations that give promise of highest returns.

A field man visited each of the cooperating farms regularly to note methods used in field operations and in chore work, to collect input and output data and financial records, to map farms and note arrangement of buildings. Detailed chore records were made.

Thirty-eight farm operators completed records for the year ending November 1, 1934.

Mr. Charles W. Harris, Jr., initiated the field work of the study. On his resignation to accept a position as county agent, Mr. Stanley W. Colby carried on field work for a brief period. Mr. Arno Hangas completed the field work and did much of the organizing and analyzing of data for publication.

Acknowledgment is made to the following farmers for their patience in keeping records and for their cooperation in studying farm management problems.

Howard Clark
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John Marshall
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Carroll Stoddard
Fred Sweet
Lew Wallace
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Arthur Young
Gerald Young

The Colebrook Area

Wholesale dairying, small scale potato production, and pulpwood logging characterize the farming activities in an area in northern Coos county comprising the agricultural lands of the towns of Stewartstown, Colebrook, Columbia, and the northern portion of Stratford. (Fig. 1).

The topography is rough and consists of broad, well-rounded hills and a few narrow valleys. Many of the farmsteads and tillage fields are on the broad tops or near the tops of these hills. For the most part the fields are irregular in shape and often steep.

The soil is good loam and the better fields are well drained. Many small areas, however, are too wet for cultivated crops and are left in permanent hay.

The growing season is very short and corn silage is grown only on a few farms. While the average time between frosts ranges from 90 to 110 days, in certain locations it is limited to about 90 days and there are occasional frosts in June and July.

The Present Agriculture

This area is one of the most concentrated dairy areas in New Hampshire. (Fig. 2). Every farm has a dairy herd, and the herds tend to be larger than in most sections of the state. The 223 commercial farms noted in the type-of-farming survey in 1935 had 3236 cows or an average of 14 on a farm. Seventy herds contained less than nine cows, 90 had 10 to 16 cows, and 69 had over 16 cows. (Fig. 3).

Two out of three dairymen raised potatoes for market, but only 20 of the 155 farmers producing potatoes commercially had over five acres. Only two operators had over 10 acres, and the average was about two acres.

Milk is marketed at wholesale to Boston dealers and potatoes are marketed mostly to local buyers who in turn ship or truck to cities farther south. Because of the location and the shortness of the growing season the area is limited in its range of crops and must gear its production largely on a wholesale basis.

History of the Area*

The first settlers entered Colebrook about 1790 and found themselves more or less isolated from markets. The mountain ridges on the east were a barrier to the coast and the trip down the Connecticut River valley was long and tedious. About 1810 a wagon road was built through Dixville Notch on the east. The Atlantic and St. Lawrence railroad touched North Stratford, 13 miles south of Colebrook, in 1847, but it was not until 1887 that the upper Coos railroad was built, making Colebrook directly accessible by railroad.

The pioneers were quick to take advantage of the favorable potato soil and climate, and heavy yields of potatoes were experienced in the early settlements.

One of the first products to be marketed under these conditions was potato whiskey. There were at least three stills in Colebrook soon after 1800. Farmers were able to barter potatoes for whiskey and some of this was in turn bartered for needed supplies and goods.

About 1846 began the development of potato starch factories and potato production on a commercial basis expanded rapidly. About 1870, there were five starch factories operating in Colebrook, four in Stewartstown, and four in Columbia, though some of the earlier factories had been discontinued. The output of starch from the area was reported as 1500 tons per year during the period of most intensive starch production. This production would require roughly 340,000 bushels of potatoes. We have no authentic record of average yields under practices followed at that time, but it is estimated

*Coolidge, A. J. and Mansfield, J. B. History and Description of New Engand. New Hampshire. Boston, 1860.
Dudley, J. A. Early History of Colebrook, Coos County History, 1888.

that with 200-bushel average yields, 1700 acres were required to supply the starch factories. One of the older men states that he sold 2400 bushels of potatoes for 31 cents a bushel about 1870. This industry, however, was destined to decline with the development of cheaper sources of starch.

Other early products, probably preceding potato whiskey, were potash and pearl ash. It is stated that much of the original forest was marketed at Portland by exchanging these concentrated products for supplies. Potash was made by leaching out wood ashes and drying the product. For further concentration, the potash was baked in large ovens at high temperatures to form pearl ash.

Dairying gradually increased in importance on a butter and cheese market and expanded even more rapidly when wholesale fluid milk markets were available.

Boston dealers finally built milk-receiving stations and opened up a wholesale market. The price of milk was sufficiently high to encourage the expansion of dairy herds and to shift management from summer to year-round dairying. Dairy production and cow population increased in Colebrook from 1900 to 1920, a period of decline in dairy farming in many sections of the state.

The organization of 38 farms

The 38 farms completing the financial and labor records are typical farms of the area. The gross returns were probably somewhat higher than for a random sample, since only commercial farms with more than nine cows were included.

In size, the farms average 20 cows and 3.5 acres of potatoes.

Financial statement of the 38 farms for the year ending November 1, 1934

Average capital investment

The financial statement reveals an estimated average capital investment of $7,879 of which $4,457 is real estate and $3,422 is personal property, livestock, machinery, and supplies.

Average receipts

The receipts for the year averaged $2,602. Sales of 87,275 pounds of milk accounted for $1,501 and sales of 1,365 bushels of potatoes brought only $311, for prices were very low. Sales of meat and livestock brought $294. The market for pulpwood was inactive during this period and only $117 worth of wood products per farm was sold, and $18 of this was from maple sirup. The miscellaneous income of $301 included outside work.

Average expenses

Expenses, including depreciation and decrease in inventory, averaged $2,022. The actual cash expenses were $1,765. An examination of the expense items indicates $589 for feed, $295 for hired labor, and $200 for seed and fertilizer.

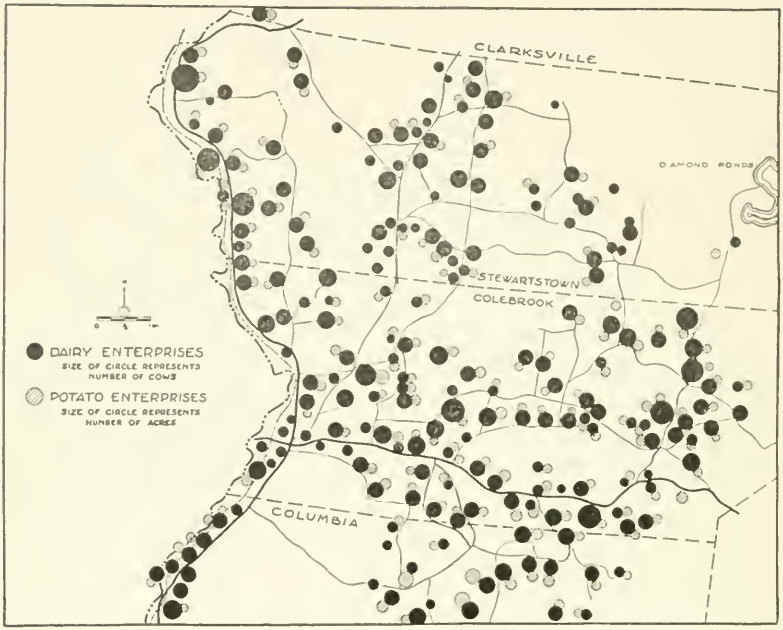

FIGURE 2. Map of the area studied showing location of dairy and potato enterprises.

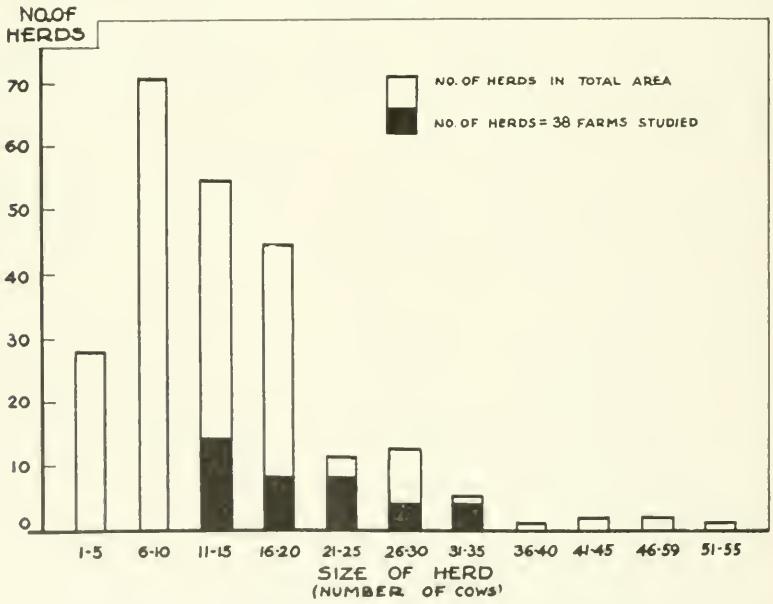

FIGURE 3. Distribution of dairy herds according to size.

The total bar indicates the number in the whole area; the black section, the number in the 38 farms studied.

Income

The total returns for capital and the operator's labor and management including unpaid family labor averaged $580 per farm. Assuming a return of five per cent on the estimated capital investment, the interest would amount to $394, leaving $186 for returns for family labor and management. 1934 was one of several bad years in the last decade for the farmers of this section.

Table I.—Summary of farm business on 38 farms (November 1, 1933, to October 31, 1934)

	Average per farm Dollars
Capital investment:	
Real estate	4456.58
Livestock	1313.17
Machinery	1034.07
Feed and supplies	1074.96
Total capital	7878.78
Receipts:	
Milk	1500.97
Eggs	61.74
Livestock and meat	293.55
Feed crops	16.35
Potatoes and other crops (sold and inventoried)	311.45
Forest products	116.61
Miscellaneous	300.92
Total	2601.59
Expenses:	
Hired labor	295.19
Feed	588.78
Livestock purchases	70.33
Seed, fertilizer, etc.	199.80
Truck, tractor expenses, gasoline, etc.	127.12
Machinery	71.57
Buildings and fences	49.40
Taxes	158.28
Insurance	39.77
Miscellaneous	164.75
Decrease in inventory	176.96
Depreciation of buildings	80.08
Total	2022.03
Farm income	579.56
Interest on investment at 5%	393.91
Labor income	185.65

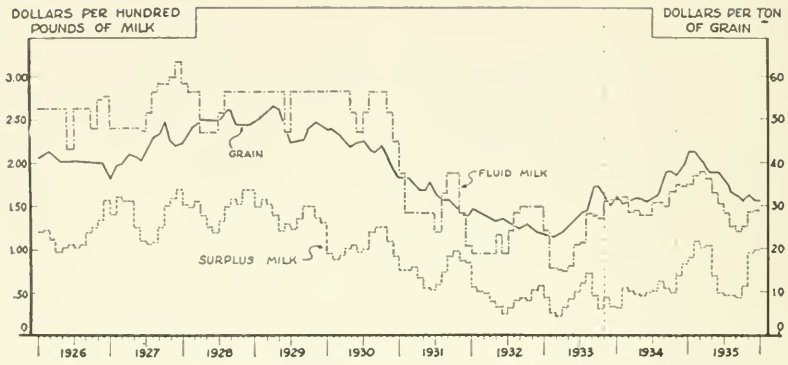

FIGURE 4. Prices of fluid and surplus milk at Colebrook, and of a 20% dairy grain ration, 1926-35.

The section between the vertical dotted lines indicates the prices during the period studied.

FIGURE 5. Potato prices on Boston market, 1926-35.

The section between the vertical dotted lines indicates the prices for the crop grown during the period studied.

One may wonder how these farm operators managed to live on $186 for the year. The answer is that they did not. Some of the men were not in debt and had the full returns for both capital and labor. Others had only small interest payments to make. Those heavily in debt had to increase their indebtedness—unfortunately this took a serious toll of the younger aggressive farmers who had not yet become established. An examination of the expense detail also reveals a decrease in inventory and an allowance for depreciation of buildings. This indicates that the men were drawing on their capital to some extent.

The Price Situation in Period of Study

The farms were under observation in a depression period and the operators were faced with discouraging prices for their products.

As shown in figure 4, fluid milk had been above $3 per 100 pounds during most of the five-year period from 1926 to 1930 and about $2 per 100 pounds in the following five-year period. For about five months previous to the study milk had been very low in price but was above $2 during most of the year studied.

Surplus milk during the year averaged about $1 per 100 pounds as compared with $1.75 in the 1926 to 1929 period.

Potates produced in the crop year under observation sold for about 20 cents per bushel at Colebrook which was the lowest price in the 10-year period. Potatoes from December to June averaged about 80 cents per hundredweight on the Boston market as compared with $1.30 for the 10-year average. (Fig. 5).

Grain prices, while higher than a year earlier, were low, especially in the first part of the period. Dairy feed averaged about $31 per ton for the year as compared with an average of about $40 for the five-year period, 1926-1930. (Fig. 4).

On account of the very low prices of potatoes the financial returns for the year were subnormal for even a depression period. The potatoes had been grown with the usual practices and yields were about normal. Had potatoes sold at a normal price for the area, the average net income would have been approximately $600 greater.

Grain Feeding

Grain feeding varied from 3,080 pounds to 169 pounds per cow. Thirty-one operators fed less than 2,000 pounds and seven fed more than 2,000 pounds per cow. In the face of low milk prices, one producer fed at the rate of one pound of grain to 2.2 pounds of milk and eight others fed more than one pound of grain to three pounds of milk. On the other extreme, eight fed less than one pound of grain to five pounds of milk. The operators had not fully adjusted themselves to the changing price situation. The rating system undoubtedly was a factor in the amount of grain feeding. Since the grain is a definite out-of-pocket expense as distinguished from the other important items of cost, such as the available labor and overhead entering into roughage production, the decision as to the amount of grain to feed should be applied at the margin. That is, with the operator's labor, the farm, and the cows available, grain can be added advantageously as long as the last pound fed returns more than it costs.

Two operators fed over 3,000 pounds of grain per cow and with low milk prices were no doubt getting small returns for the last unit of grain fed. In both cases the additional production resulting from forced feeding was sold at surplus prices. Dairy management becomes a rule of thumb procedure with some operators and they continue with a static management in a dynamic universe.

In figure 6 the herds have been arranged to show gross income per cow on the left and gross income less grain cost on the right. The greater the cost of grain per cow the greater the slant of the lines. This item in itself does not indicate a measure of efficiency or economy in feeding, but it is evident in studying the chart that

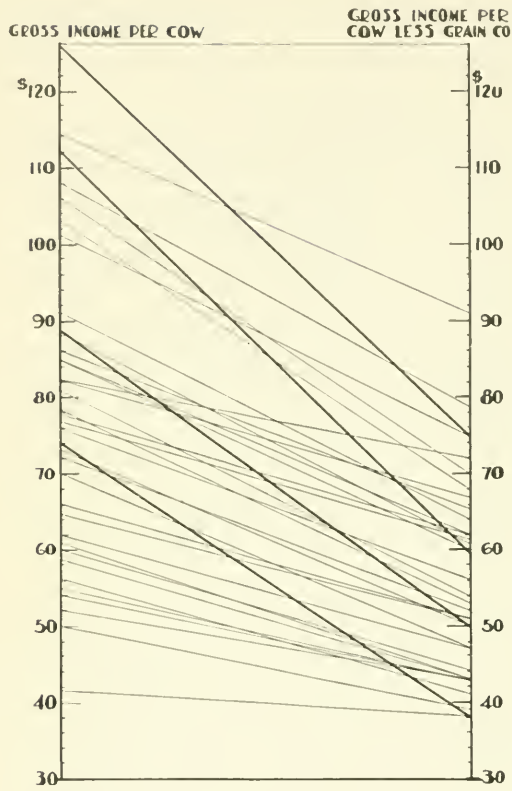

Figure 6. Relation between gross income per cow and gross income less grain cost per cow on individual farms.

some operators who fed a large amount of grain had no larger return over grain cost per cow than others who fed less grain.

Four farms, represented in heavy lines in figure 6, stand out in particular as instances in which the grain cost took a large toll from the total receipts. The first farm with a gross income of $120 per cow had no larger net returns than three other farms with more moderate grain feeding. The second farm with $112 gross per cow had no larger net returns than 13 others with less gross sales and less grain feeding. All the facts are not available to determine the most profitable amount of grain to feed on these individual farms but these four farms were undoubtedly feeding more grain than the price situation justified. A few at the other extreme were not feeding sufficient grain to secure the highest net profit. Some of the very low grain feeding was induced by a lack of money to purchase grain at this period in the depression.

A study of these same farms at a time when prices of both milk and grain had been stabilized for several years would probably show less divergence in grain feeding. The abnormal shift in prices, the lack of operating funds on some farms, and basic rating difficulties confused the operators and resulted in wide variations in practices.

It may be well to note that the additional milk produced beyond the point of profitable grain feeding contributed to the general surplus situation.

Chore Labor

Man labor required in daily chore work on cows and heifers is an important item of cost in milk production, but because it largely represents the labor of the operator or his family it must be handled differently in arriving at decisions. Man labor used directly on chores averaged 7.4 hours per day on the 38 farms. The average time required per cow was 148 hours. However, the time on individual

farms varied from 87.6 to 285 hours a year. It is difficult to account for all the differences in time. The handiness of the stable, the handling efficiency of the milking machines, the detailed job planning by the operator and the quickness of the men on individual practices were important factors. One or more operators were not especially interested in cows and probably fell somewhat short of standard practices. Several men put a large amount of extra time on their cows, partly because they were interested.

The importance of efficient chore work is largely in the freeing of time for other productive work or needed leisure. Thirteen operators who put more than 150 hours per cow on dairy chore work were not very efficient. They had, on the whole, smaller herds, and hand milking and cleaning of the stable required more time. Then, too, on these farms with smaller herds, chore work during the winter is part of the operator's life. There is no great incentive to quicken the pace. Given their resources in hay and cows they would not be materially ahead if they could do the chores in less time. However, more efficient chores would enable them to keep more cows and in the summer shorter chore time would enable the operator to put more time on hay harvest, potatoes, or other productive work. Thus chore efficiency is important, but only if the time saved can be used to good advantage.

In this respect it is well to note that in the five herds with over 30 cows the average labor requirement was 110 hours per cow and that with all five herds it was under 125 hours per cow.

An average of 10.3 hours daily was required in taking care of the 31.7 cows in this group. On the basis of a two-man dairy farm something over 5.1 hours would be required of each man.

On one farm of this group with an average of 32.2 cows, the layout of the barn and the procedure in chore work was fairly efficient. An average of 10.9 hours was required per day in chore work with cows and heifers. For seven months of barn feeding the chore work began at 5.30 a. m. and ended at 7.15 p. m. and for the other five months began at 5.00 a. m. and ended at 7.45 p. m. As can be noted in the diagrams, this left free time for other activities in summer from 7.30 to 12.00 and 1.00 to 5.30 and in winter 8.30 to 12.00 for one man and 1.00 to 4.00 for both men.

This arrangement in the summer enables the operator to put in a nine-hour day in the field when weather and other conditions are favorable (Fig. 7). In the winter the free time is short but does enable the operator to put up ice and get his wood supply. For about three months in the winter the operator could arrange for one man to work in the woods from 8.30 to 4.30. The use of a team or a truck to advantage might require an additional man when working aggressively on pulpwood or lumbering.

Thus from the viewpoint of an aggressive farm organization the systematizing of chore work to reduce the time to the minimum and still do effective work is the foundation of successful dairying. If the chores drag out, the use of men and teams is not effective.

An average of 3.24 hours was required per 100 pounds of milk produced. Four operators used more than four hours per 100 pounds

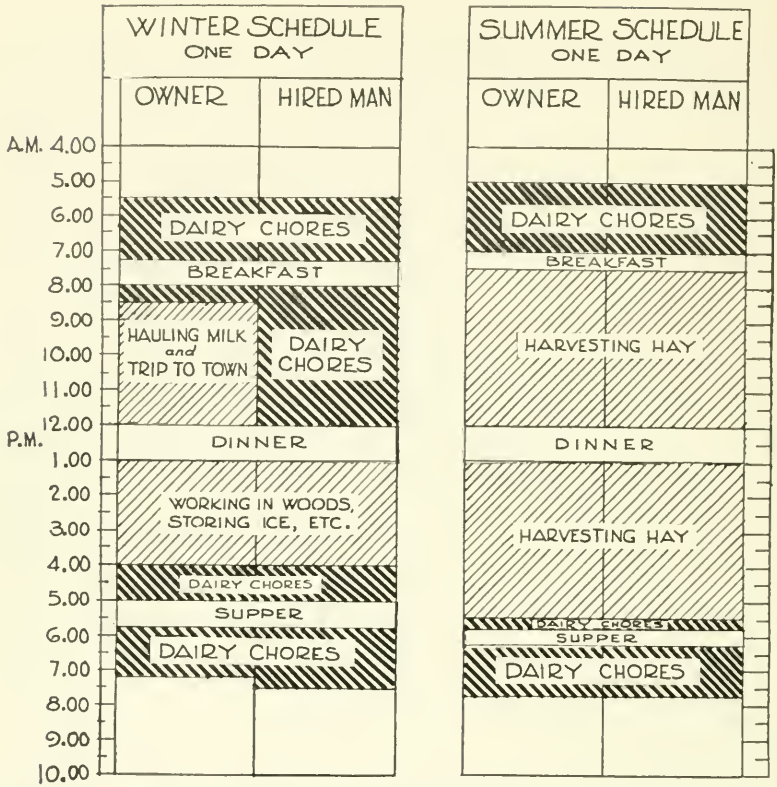

FIGURE 7. Winter and summer chore schedule showing how one operator divided his day among the various farm operations.

of milk. With milk wholesaling for about $1.50 per 100 pounds, the return per hour for chore work was, of course, rather low. In the Grafton county study two years earlier,* an average of 2.9 hours per 100 pounds was required.

Detailed chore records were made on 10 farms. The travel of the operators was recorded by laying down strings on a mounted floor plan of the barn. The time for each practice was noted with a stop watch. A study of the chore record charts (not shown in the bulletin) reveals a great deal of travel in chore work on all farms studied. On one farm particularly, the arrangement of the barn was such that the cows were scattered and each operation in turn required considerable travel. In a well-designed barn a crew of two men could do the work as advantageously as three men could do it in this barn.

There were marked differences in the use of machines as shown in Table II. Operator F had the machines on the cows about half as long as operator A but put .7 of a minute more per cow daily on

*Bulletin 275, "Efficiency Studies in Dairy Farming," H. C. Woodworth, C. W. Harris, Jr., and Emil Raschenstein, New Hampshire Agricultural Experiment Station in Cooperation with the Bureau of Agricultural Economics, United States Department of Agriculture.

hand stripping. An inspection by the field man revealed that some of the milking machine equipment had not been kept up. On some farms the valves were leaky, rubbers were worn, and the general efficiency of the milking process curtailed.

Harvesting Hay

In the harvesting of 2,750 tons of hay on 1,905 acres, 18,400 hours of man labor and 13,495 hours of horse labor were required. This is an average of 9.7 hours of man labor per acre or 6. 7 hours per ton. Sixteen operators required more than 10 hours per acre and 15 over eight hours per ton. In general the men with the larger labor requirements did considerable hand work in such practices as bunching and raking. The ability to organize a small crew so that all the men are doing really productive and essential labor seemed to be the chief explanation of low labor requirements. The five operators with hay loaders had an average labor requirement of 5.3 hours per ton, but eight operators without loaders used fewer hours.

The harvesting of hay is the chief field operation on these dairy farms and about a third of the operators do not use efficient practices in getting the crop cured and under cover.

Silage production

The story of roughage production would not be complete without reference to the two farms which produced silage. On the basis of hay equivalent, assuming that three tons of silage are equivalent to one ton of hay, more man and horse labor are needed but less land is required for silage production. However, most of the labor on silage comes in the spring and fall and so the requirements do not seriously compete with hay harvest. Silage does compete with potatoes to some extent in labor requirement but a small acreage of silage can be grown without serious conflict and without limiting the potato acreage to any great degree. The most serious conflict came at harvest time and both operators were able to harvest corn silage advantageously before potato harvest began.

Table II.—Comparison of machine milking operations on eight farms

	Minutes machine operating time per cow		Pounds milk drawn per minute		Minutes stripping per cow	
Farm No.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
A	9.	9.4	1.6	1.8	1.2	1.3
B	9.	6.7	1.2	1.4	.9	.6
C	5.7	4.4	1.7	1.6	1.9	2.0
D	7.5	7.1	1.3	1.7	2.5	2.2
E	4.7	4.2	1.9	2.1	2.5	1.8
F	4.4	5.4	2.8	2.3	2.0	1.2
G	6.3	6.6	1.5	1.4	1.5	1.7
H	9.2	7.8	1.8	1.6	.8	1.3

Table III.—Combinations of land and labor to produce the equivalent of one ton of hay
(Assuming three tons silage are equivalent to one ton hay)

		Acres of land	Hours of man labor	Hours of horse labor
Farm X	Silage	.3	7.3	16
	Hay	.84	6.1	6
Farm Y	Silage	.3	19	16
	Hay	.57	10	9

Since there is no better productive opportunity for the use of available labor and teams in the spring and fall, silage production is a good practice on the two farms in spite of the fact that more total man and horse hours are required per feed unit.

On the basis of a definite wage scale and allocation of all overhead, hay would probably represent a cheaper form of roughage on these farms, but the production of the combination of one acre of silage to five acres of hay uses the available man and horse labor to better advantage and results in greater total feed units. Silos and silo machinery were available on these farms.

Oats

An average of 5.8 acres of oats was grown per farm. All operators grew oats and most of them threshed all or part of the crop. On most farms in the area oats are cut for hay when roughage is short and harvested for grain when roughage is plentiful. This crop is used as part of the process of reseeding and the time required is more or less a joint production factor with hay production. The process results in more and better hay and is a factor in keeping up the yielding capacity of the fields. The labor on oats is not seasonally competitive with other production. However, the labor requirement for harvesting and threshing is especially high and the operators can well consider changing their present practices.

Manure Hauling

The handling and spreading of manure is an important item of labor expense and is, to a large extent, part of the process of producing milk. On the average, 252 man hours and 286 horse hours were required per farm in getting the manure distributed. Since there is some leeway as to the time of this operation, the labor required can be fitted into slack periods. On individual farms the labor requirement varied from .5 to 3.5 man hours per ton. A few of the men handled the manure a number of times, hauling it to the fields in carts, distributing into small piles and then scattering by hand forks. Some hauled directly from the barns to the fields in manure spreader. A few hauled to large field piles in the winter and then used manure spreader for distribution in the spring. While this method requires more total hours and an extra handling, less time is needed in the rush period of spring.

Eleven of the operators used over 1.5 man hours per ton of manure which is not an efficient operation.

The Farm as a Factor in Production

Labor, grain, and roughage are commonly considered to be the chief inputs entering into milk production. This breakdown of factors represents a simple procedure in studying certain phases of dairy management. However, in a specialized dairy region where most of the crop area is devoted to roughage production and where the dairy cow has no near competitor for the hay, there is something to be gained in the operator's appreciation of his management problem if the breakdown of production factors is made on the basis of the farm, the operator's labor, purchased grain, etc.

Thus the production of roughage is included as part of the procedure in producing milk. These factors, hay production and milk production, can, in fact, be separated only on the basis of arbitrary allocations. The yields of hay in New England, for instance, are very dependent on the dairy. With the feeding of purchased grain, the intelligent handling of manure, and the aggressive management of soils, the land can be maintained in high-yielding capacity. The value of the manure and the hay in turn is dependent somewhat on the value of milk.

On the average, the tillage land supported livestock at the rate of .37 cows per acre, including young stock, and .55 animal units per acre. But on individual farms tillage land varies widely in its carrying capacity.* The number of cows varied from .18 to .76 per acre and the animal units from .29 to 1.27 per acre. This ratio of livestock to tillage land is an important factor in dairy farm management from several angles.

The amount of livestock determines the total amount of manure available and the most economic use of this available manure is an important problem which progressively changes with low to high stock-tillage ratios. Under conditions existing in New Hampshire, the amount of manure available over a period of years largely determines the extent of the agricultural activities. In some instances the man with a large tillage acreage and little livestock fully operates part of his farm and half operates the rest, the yields of hay being so low on the latter part that he sometimes doubts the value of harvesting hay at all.

On the other hand a few operators with limited tillage land have gradually built up yields to the point where the manure available could be used more effectively if more land were available.

Some of the tillage land was devoted to potato and grain production and the numbers of livestock supported by acres of roughage were somewhat greater. On an average, .4 cows or including young stock .6 animal units were supported per acre of tillage in hay or silage. On nine farms less than .5 animal units and on six farms more than .8 animal units were carried per acre. If the 18 farms with less than .4 cows per acre of roughage could be brought up to

*A few farmers purchased a limited amount of hay.

this average, an additional 89 cows could be supported, as far as roughage is concerned. Much of this difference in yields is due to the management of the land over a period of years.

The yields of hay averaged 1.4 tons per acre but varied from .7 to 2.4 tons. On some of the farms, especially those with low average yields, certain fields produced less than half a ton per acre. These are generally the fields that have not been reseeded or mowed for several years.

The operators on farms with low livestock-tillage ratios are greatly handicapped, and the process of building up the yields is likely to cover a period of low income. However, as long as the individual is operating that farm he is handicapped anyway, and there are advantages in a definite and aggressive program of action. This action program may call for more livestock, more seeding down, some commercial fertilizer in connection with the rotation, and importing hay harvested on abandoned farms. Thus, if the operator on a farm which normally could carry 20 cows can find a means of providing roughage for that number for a few years, the farm will be built up to carry the normal amount of livestock. The purchase of hay and the application of fertilizer to hay and pasture lands may be large during this initial period and, unless milk can be sold advantageously, such an undertaking as described above is a questionable practice. It not only involves expense and labor but a long period of waiting for production.

Net Increase in Dairy Cattle

The process of maintaining the dairy herd is an essential part of milk production. Heifer calves are available for development into producing cows and the extent of this "cow production" is a problem of management to be solved on the individual farm in the light of such factors as the roughage and pasture available, the number of cows that may be conveniently handled, the price of milk, and opportunity of disposing of cows or heifers to advantage. There is a rather wide variation of practices and alternatives open to the individual farmer.

If roughage is limited and milk is high in value, there is a tendency to keep cows through the period of high production, growing only such heifers as are needed to replace the old or worn-out cows. About one-fifth of the cows will need to be replaced each year under careful management. Under this system of keeping the individual cows through most of their productive life the returns from livestock sales will be insignificant.

But if roughage and pasture are available and the milk price is low, the growing of more replacements and the sale of good cows may be an important part of the dairy enterprise. Under these conditions the operator is willing to sacrifice something in milk production for greater sales of stock. Consequently he moves his animals at the period of high sales values and maintains a herd made up mostly of young heifers. He moves one-third to one-fourth of the herd each year and must therefore raise a large number of heifers.

On the 38 farms there was an average of .39 heifers per cow which is not in excess of the needs of replacements of present herds. Only 12 operators had more than .5 heifers per cow and only a few operators were selling many producing dairy cows. On the whole, the operators were producing milk rather than cows in spite of the low milk prices. Counting sales, purchases, and differences in inventory at the beginning and end of the year, the net gain from livestock averaged $182 per farm. Only five farms had a net increase of livestock, including sales, of over $400. Eight operators had a net livestock increase amounting to over $20 per cow and the highest was $40.50 per cow.

One is well aware that a high type of dairying is required in the production and sale of good dairy cows. The operators who have good foundation stock, have abundance of roughage and pasture, and are qualified by skill should consider the production and sale of cows. For them, the combination of milk and cows is likely to be more profitable than milk production. Such a plan usually involves little if any additional labor. The quality of the cows must be good and some special skill is required in growing out heifers and in marketing them.

One man with an average of 10.6 cows and 6.5 heifers had a net increase of $38.90 in livestock per cow, while another man with an average of 11.7 cows and 9.0 heifers had a net increase of only $4.77 per cow.

The first operator sold two good cows for $80 each and one discard at $45 while the second man sold several discards for $10 and $15 each. On several farms cows are used up so rapidly that a large number of heifers must be raised for replacements. In spite of a heavy expense in growing out many heifers there was very little income from livestock sales.

Under these conditions the replacements represent such a heavy cost that dairying cannot be expected to furnish an adequate income to the operator.

Some of this cost was due to careless crowding of stock in stables and the consequent impairment of teats and udders through mechanical injury. Contagious abortion was a factor in a few instances.

Seasonal Milk Production

The dairy industry is interested in adjusting seasonal supplies to seasonal demand for fluid milk. From time to time the marketing cooperatives have devised basic ratings and other plans with the intent of regulating the supplies of milk coming to the large markets.

Under the base rating plan, each producer is given a base which is usually assigned to him according to his deliveries in a given period in the previous year. In setting up the plan, the intention is that the total basic ratings will approximately equal the fluid milk sales in the market. The producer receives a fluid milk price for that portion of his deliveries falling within his rating, and a Class two price for all milk in excess of the rating.

The objective has been to insure and encourage sufficient supplies at all times in relation to demand at normal prices, but to control the

marketing of huge surpluses seeking fluid prices at any season. Uneven production does present certain serious problems to the industry within the milkshed, and the cooperatives have been as anxious to prevent a milk shortage at any period as to discourage overproduction at another period. Either situation is detrimental to the industry as a whole.

On the other hand, the individual producer interested in the use of his peculiar resources and the management of his herd to maximize his income may not find it profitable to have an even production. Certain resources such as available pasture may not have a better alternative resource. This situation may be relatively more common as one travels from the market to the more distant zones of the milkshed where profitable dairying is likely to be on a more extensive basis. In an area as far from the market as Colebrook the wholesale price of fluid milk as well as the price of surplus is normally low and the operator must take advantage of all his resources.

The average daily milk production on the 38 farms was lowest in February with 220 pounds and highest in June with 340 pounds. (Fig. 8). Except for a two-months' period from May 15 to July 15 the daily average production did not vary more than 35 pounds above or below 250 pounds. While there was a marked peak of

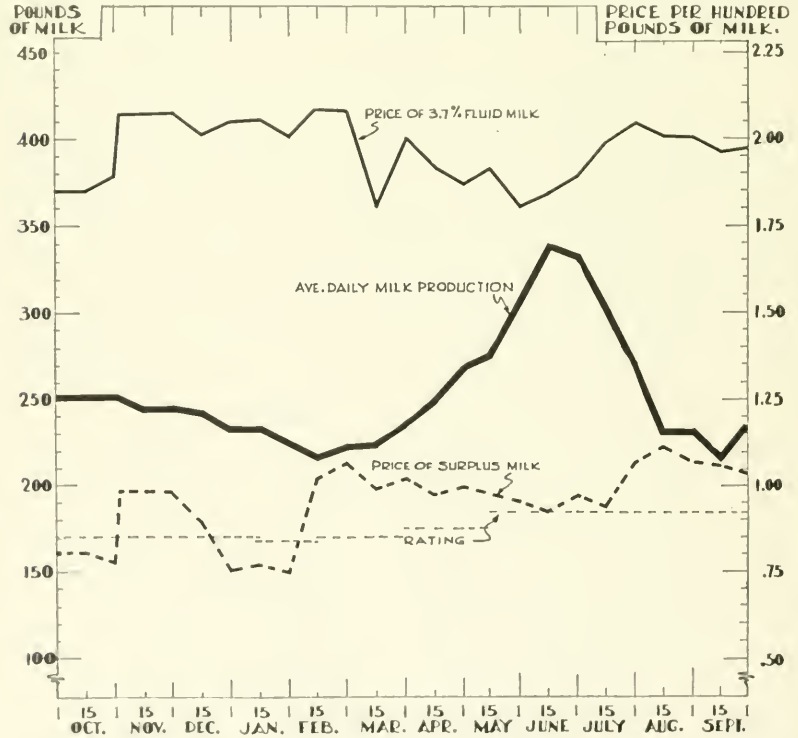

Figure 8. Average daily milk production, rating, and prices for fluid and surplus milk on the 38 farms during the period studied.

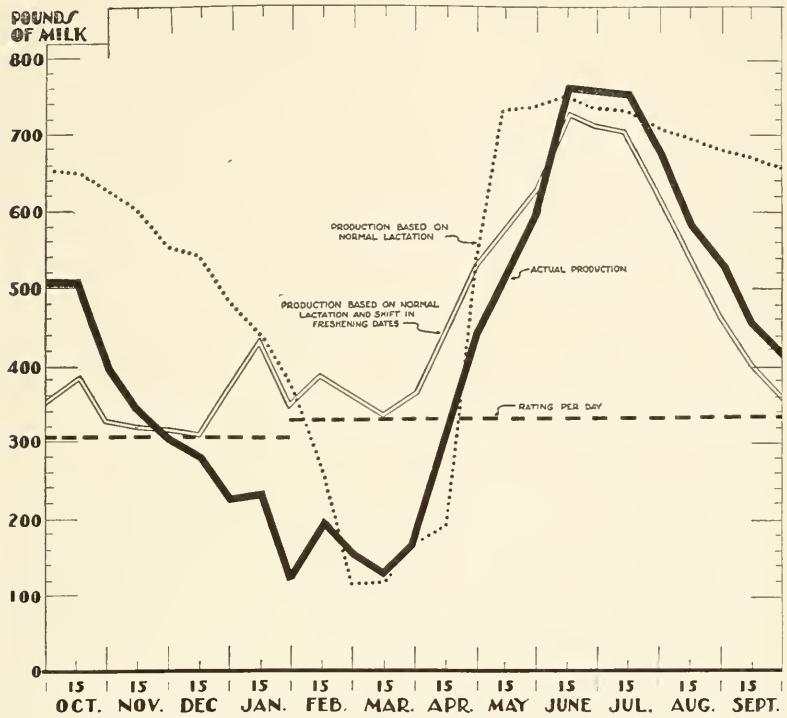

FIGURE 9. Comparison of actual milk production with the rating and with normal milk production for a herd with uneven production.

Normal milk production is based on a normal lactation curve. In order to show how production could be evened out, a curve was drawn based on a shift in freshening dates and change in feeding practices for part of the herd.

production in the flush pasture season, the production was stable for the other 10 months.

When compared with the average daily production in the Haverhill area in 1929, there appears a substantial difference.* The Colebrook area is characterized by a marked increase in spring pasture season and the Haverhill area by a marked reduction in late summer. These differences result from the farmer's adjustment to his resources and the market. The Colebrook operators with better pastures and lower milk prices tended to carry flush production in June, while the Haverhill farmers with a special Grade A market and a long established rating system tended to plan a production that would protect their ratings and maximize their returns.

Eleven of the 38 operators in the Colebrook area had large surpluses in the flush pasture season. Farm D represents an extreme case. (Fig. 9). The production ranged from 150 pounds in the first quarter of the year to 750 pounds in the flush pasture period in June. On this farm 81 per cent of the cows freshened in March and

*Bulletin 275, "Efficiency Studies in Dairy Farming"

April, but within five months, after flush pasture season, production had declined 43 per cent. This operator fed only small amounts of grain and depended largely on unimproved permanent pasture to support milk production. The rapid decline in production after the June flush period suggests that the cows were not obtaining sufficient nutrients to maintain a normal rate of production.

With an abundance of quality roughage, either in the form of improved permanent pasturage or supplemental pastures, production should hold up during the late summer without heavy grain feeding. The cows would then be in a better condition to maintain production through the winter.

To study the seasonal production on this farm in more detail, a normal expected lactation production curve was assumed for cows capable of producing approximately 25 pounds of milk at freshening time. This curve was applied to each freshening date for the year and summarized into a normal production for the herd.

As indicated in figure 9 the actual production curve declines much more rapidly in midsummer than the expected normal curve. On this particular farm the operator had over 80 per cent of his cows freshen in March and April in order to take advantage of the flush pasture period, but this advantage was soon lost by failure to furnish sufficient quality pasturage or roughage in late summer.

Had production followed the normal production curve, the additional 43,852 pounds of milk would have resulted in $418 additional gross income. Because of the low basic rating on this farm much of the additional production would have been classified as surplus. The problem facing the individual operator is more complicated than can be stated in simple terms, but he needs to consider how far he can profitably proceed toward a normal production when the full attainment would gross only $418 additional income.

We do not have sufficient data to discuss the problem in great detail, but the normal production and adjustment to his basic rating would require:

1. Supplemental pastures or improved pastures
2. Shifting of freshening dates on one-fourth of the herd
3. Additional grain feeding

The long range adjustment might well be the improvement of a limited acreage of permanent pasture. This would involve the use of lime and superphosphate on pastures to stimulate clover and extend the good pasture season. Even under these conditions until the permanent pastures are developed, considerable supplementary pasturage will be required. Much of the labor necessary to produce supplementary pasture feed could be done at slack periods on this farm. The actual out-of-pocket costs in the form of seed and fertilizer would be small.

Since the operator did not produce up to his rating in December, January, February and March, he could arrange to have more cows freshen in the fall. It might be to his advantage to have a distinct feeding practice for the fall freshening cows, carrying them on a heavier grain feeding through most of the year. Thus, he would be managing his fall freshening cows to take advantage of the rating

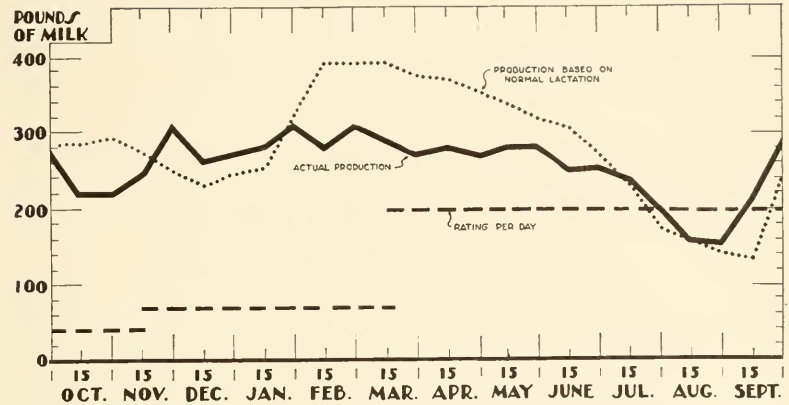

FIGURE 10. Comparison of actual milk production with the rating and also with milk production based on a normal lactation curve, for a herd with relatively even production.

and his spring freshening cows to use his available pasture resources. Having carried the cows in good production to the barn-feeding period on good pasture, he might feed his spring freshening cows more grain. It is doubtful if he could profitably feed more than a moderate amount at the surplus milk prices obtaining at the time.

The goal of the individual operator would not be to level off production but to manage his resources to have the highest net returns. By providing supplementary pasture roughage and shifting the freshening dates of a few cows to the fall, he could substitute a production range of from 400 to 600 pounds for the present 150 to 750 pounds. This would have involved 13,780 pounds additional production during the year and an estimated additional gross income of $209. On the expense side, additional cash outlays would require $200 for grain, seed and fertilizer.

The production on farm C was similar to D, ranging from 200 pounds in January to 800 pounds in June. The 800 pounds production on flush pasture declined to 240 pounds in three months. But this operator supplied his rating at all periods, and to build a better rating under the conditions would require forced and uneconomic production in the fall at surplus prices.

On the other hand, the operator with a rating more in keeping with his farm could adjust grain feeding and other practices to advantage. But the possibilities of these economies are offset by practices followed on individual farms in establishing the rating. Thus the method of establishing individual rating rather than the rating principle is responsible for uneconomic practices. Historically, the rating was based on production in short periods of previous years. Those with good ratings could hold them but individuals without good ratings found it difficult to even off production to meet the market needs.

For the period under study the rated milk averaged $2.00 and the excess $1.00.* Thus due to differences in ratings, operators shipping

*Rating plan not in operation now.

the same quality of milk to the same market through the same agency received wide differences in rate per hundredweight and some of the differences are difficult to defend on the basis of the current year's operations. Thus Farm A in figure 10 with 3.5 per cent milk received $1.44 per hundredweight, in comparison with $1.76 on Farm B testing 3.3 per cent.

The production of milk on Farm A meets the market requirement nearly as well as Farm B and yet 46.7 per cent of the total sales for the period brought surplus prices as compared with 8.3 per cent for the latter.

Potatoes

In producing the chief cash crop of potatoes an average of 145.6 hours of man labor and 98.6 hours of horse labor were required per acre. Only seven operators required less than 100 man hours and four required more than 200 hours of man labor. Many of the farmers have cut production costs since the potato study of 1930 but at least 14 of the operators have very high labor requirements.* These can well examine present practices.

The chief difference in production costs arises out of the digging operation and since this represents a peak in labor requirement, better practices in this operation would level off the labor load or enable the operator to grow a larger acreage with present labor. Several operators with small acreages or rocky land do not attempt to use diggers. On several larger acreages the witch grass develops a thick sod late in the season after the vines have declined and the digging operation, either by hand or by machinery, is greatly handicapped. Ten operators used 100 or more hours in digging potatoes and hauling to storage.

An average of 1,869 pounds of fertilizer, 20 bushels of seed, and $5 for spray material was used per acre.

Total Labor Requirements

Since oats, hay, silage crops, and potatoes have different seasonal demands for labor and power, a combination of these crops which takes full advantage of available labor may be more profitable than specializing in any one crop. The four figures 11, 12, 13, and 14 indicate the distribution of the man labor on four farms. In the first case (Fig. 11) on a dairy farm with 27 cows, one acre of potatoes, 75 acres of hay, and 10 acres of grain, there are slack labor periods in June, the last part of August, and short periods in September and October.

On the second farm (Fig. 12) with 16 cows, 52 acres of hay, 5 acres of grain, and five acres of potatoes, the labor demand in September and October is raised considerably by potato harvest. There were slack periods in June, the first 10 days of July, and the first 10 days of September.

On the third farm (Fig. 13) with 19 cows, 40 acres of hay, 14 acres of grain, and 10 acres of potatoes, there was a high labor require-

*Bulletin 239, "Potato Production Costs in New Hampshire," M. F. Abell, New Hampshire Agricultural Experiment Station.

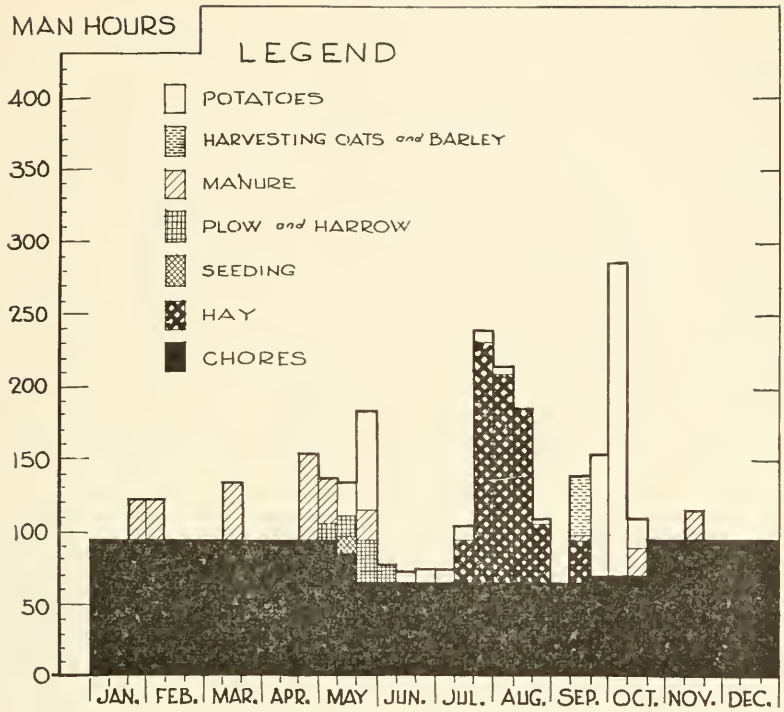

FIGURE 11. Labor requirements by ten-day periods on a farm with 27 cows and 1 acre of potatoes.

ment most of the crop season, the last of June and July 10 being somewhat slack.

On the fourth farm (Fig. 14) with 32 cows, 62 acres of hay, eight acres of oats, 15 acres of silage, and six acres of potatoes, the distribution of labor requirement made use of available labor through most of the crop season; the last 10 days of June were slack. There were peaks in amount of labor required in August and September. The peak in August resulted from a combination of hay harvesting and plowing for the next year's crop. The harvesting of the silage crop which furnishes 38 per cent of the feed units in the roughage consumed on this farm accounted for the peak in September.

Factors other than labor, of course, must be considered, but a study of these four farms indicates the possibilities of combining crops to use available labor.

Adjustment problems

Patterns of land ownership and control are seldom in complete harmony with the most advantageous use of land. With better practices and new developments in labor-saving machinery, with the changes in the individual operator's experience, ability, and capital, and with different price relationships, old patterns of land occupa-

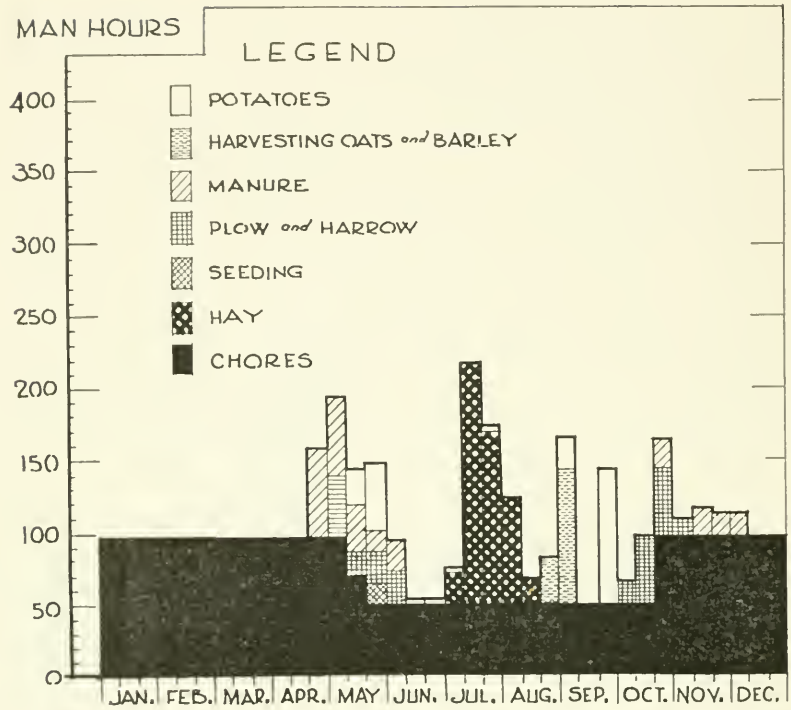

FIGURE 12. Labor requirements by ten-day periods on a farm with 16 cows and 5 acres of potatoes.

tion become handicaps to the most efficient production. Farm operators have had to organize their businesses on the basis of land under their control and are continually adjusting themselves to changing conditions by new combinations of crops with high and low labor requirements, and by varying the intensity of management on each crop. Thus it is not unusual to find in the same community one farmer carrying on a too intensive management and another farmer too extensive management for best results, yet each operator has the best possible organization considering the land area under his control. Therefore, in studying possible long-time adjustments in this area, attention should be given to the possibility of changing boundary lines and revamping farm areas instead of taking for granted the present pattern of ownership or type of agriculture.

There were in this group of 38 farms several operators who were definitely handicapped by small tillage areas. Twelve had less than 40 acres of cropland. A few had larger woodland areas than needed to use available labor effectively, while many others had only small woodlots. Some farmers had practically no woodland resources on which to use available labor and equipment in the winter months.

Present tillage areas are generally somewhat scattered and most of the land area not now in tillage is too rough or rocky to be considered as potential tillage under present price situations.

An expansion of tillage land usually involves the purchase of an entire farm including tillage, pasture, woodland, and buildings. The addition of a whole farm may result in a greater maladjustment and will require a considerable capital investment. Under conditions of partial abandonment of farms or the destruction of buildings by fire, tillage land can be added without great cost. Some of the better organized farms in the study have been built up by combining small adjacent farms. A few men have purchased abandoned farms several miles away and use the tillage land for pasture for dry cows and young stock. Occasionally potatoes are grown on the old tillage land and in a few instances the hay is harvested and drawn to the home farm. On a long-time basis, the gradual decline of yields on these semi-abandoned distant fields will result in abandonment for hay production. This situation makes it all the more necessary for individual farmers to work out economic units in which tillage and pasture are easily accessible to the farmstead. With a

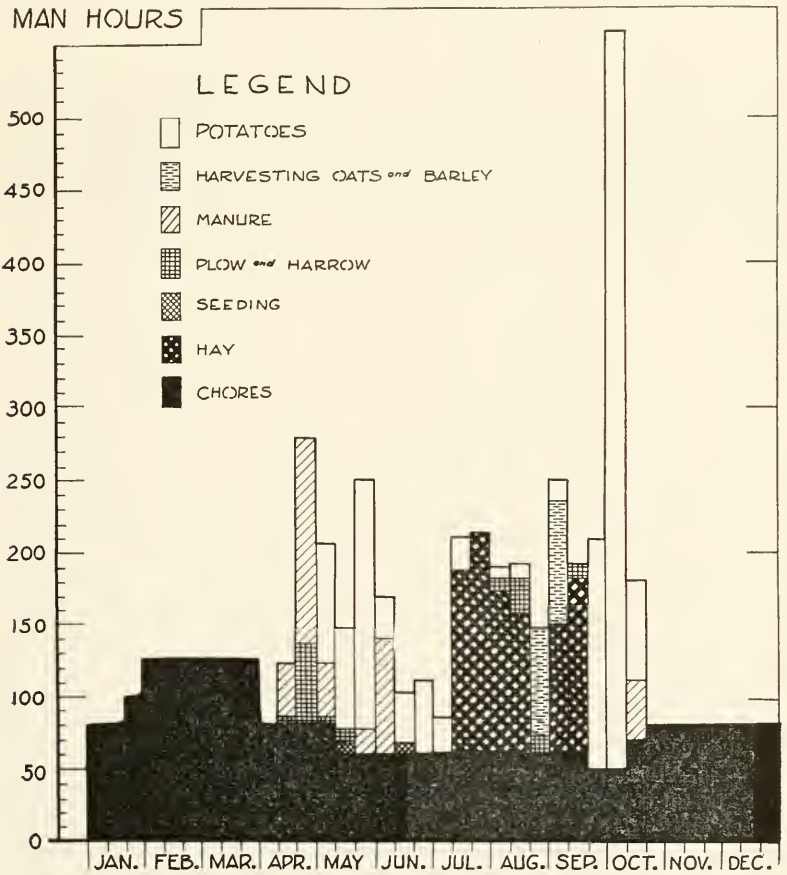

FIGURE 13. Labor requirements by ten-day periods on a farm with 19 cows and 10 acres of potatoes

few exceptions this will mean adjustments within present boundary lines. More intensive management to secure higher yields of hay may be more logical than attempting to add additional tillage.

In the usual situation the operator is rather definitely limited as to tillage land available to him, and he must gear his farm organization more or less around this available tillage land. If he will not have sufficient roughage for the requirements of the dairy herd of a size which is logical and economic in relation to available labor, he can improve pastures to carry the stock for a longer pasture season and can by intensive management increase the yields of roughage on the limited tillage land. On many of the farms in this area corn silage cannot be depended upon. A shorter rotation involving more frequent reseeding and the use of a high-yielding annual hay crop in the rotation represent possible adjustments to intensify the use of land where tillage area is limited.

On most farms in the region pasturage under present management is not adequate to fill the requirements of dairy cows for the entire season, but this deficiency can be met by a more intensive pasture program on part of the area now available.

On the whole, the possibility of adjusting the present pattern of ownership to balance the individual farm organization is more feasible through woodlot ownership. While most farms have considerable woodland acreage, many are without forest resources on which labor can be productively applied. In the more concentrated dairy farm area of Colebrook the acreage of woodland per farm is low.

The net income to the operators on these farms without timber resources could be raised by productive employment of man and team on woodlands for short periods in the winter. The possibility of developing the timber resources on the limited woodland areas and the acquiring of additional woodland should be considered.

The Combination of Milk and Potato Production

The production of milk has been the foundation of the farm economy of the region for several decades. Dairying tends to maintain the productivity of the tillage land. It affords employment throughout the year. The returns per hour may not be large, but the moderate returns for the large total of hours required result in substantial total returns for the year.

The Colebrook operators in common with other New England farmers have a comparative advantage in the production of fluid milk to fill the demands of the local New England markets. The Colebrook area is in the 241-250-mile milk zone from Boston and thus subject to heavy transportation costs as compared to southern New England, but has offsetting advantages in better pastures and good hay lands.* The farms in the area will no doubt continue to be a factor in the fluid milk market. But even without this special market, milk production for butter or cream would probably be a better alternative than other livestock enterprises. The gross income from other livestock would be low, and agriculture would

*The freight on milk from Colebrook to Boston from December, 1934, to July, 1939, has been $1.8 per hundredweight.

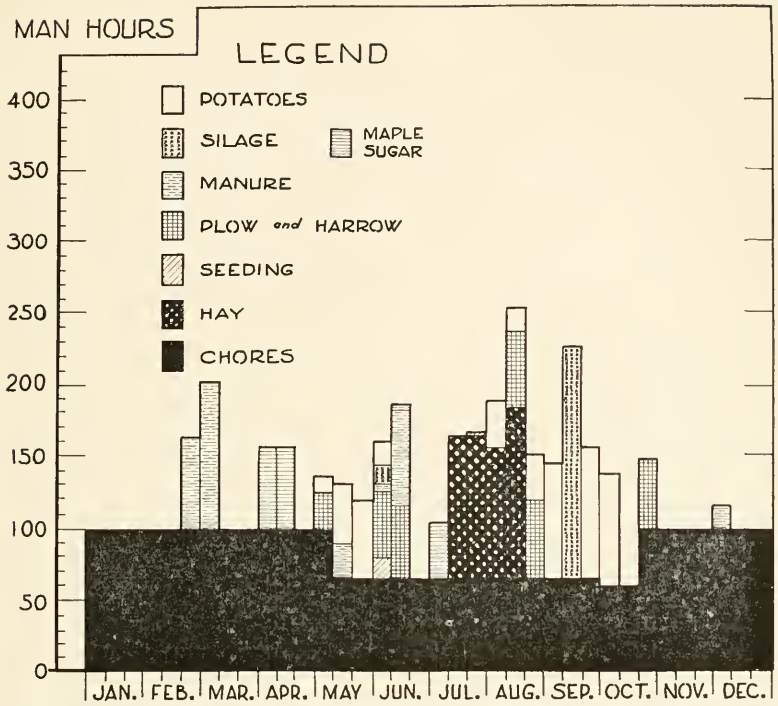

FIGURE 14. Labor requirements by ten-day periods on a farm with 32 cows and 15 acres of silage.

probably decline with the draining off of young men by more attractive occupations elsewhere.

The production of potatoes as a major enterprise without livestock would not be very profitable because on most farms the nature of the soil and the topography are handicaps to low cost production. Thus in spite of only moderate returns from dairying, there is considerable doubt if the community could continue in commercial agriculture without the dairy cow.

Assuming a share in the fluid milk market, dairying can be accepted as the principal enterprise of the farms in the region, with potatoes, dairy replacements, and timber supplementary activities.

In proportioning these enterprises to secure the highest income combination, the individual farmer has evolved an organization on the basis of trial and error. This is a good procedure except that the extreme fluctuation in price of potatoes and the considerable change in the price of milk in recent years has resulted in confusion. This probably accounts for the lack of correlation between sizes of herds and acres of potatoes.

In the determination of the best combination of dairy and potatoes on a given farm, the net return per acre or net return per hour of labor from each enterprise is of little value. Within certain lim-

its the two enterprises are not competitive for the available labor or for land.

Dairying is associated with the production of hay and other roughage. The production of hay with its requirement of land and labor also makes possible the dairy enterprise with its requirement of labor directly on cows and on such other activities as manure hauling. For this region as a whole, hay production cannot be considered alone, for its market is associated intimately with dairying in general.

In considering crop enterprises, therefore, while labor requirements in haying range from 5.2 to 24.7 man hours and average 9.7 man hours per acre on the group of farms, each acre on the average supported an additional labor requirement of approximately 54 hours directly on dairying and five hours on associated activities. Dairying involves both feed production and care of dairy animals. On the crop side, hay production represents an extensive use of land, yet from the dairy enterprise point of view it supports an intensive business. As an average for all the farms the requirements for potatoes were 141 man hours per acre and for hay and dairying approximately 69 hours per acre. Even these data must be taken as estimates because a sharp division between potatoes and hay involves arbitrary allocations of labor and other costs in certain practices.

In this region both hay and potatoes are associated with high labor requirements per acre, with the relation of 140 man hours for potatoes to 70 for hay. The essential difference is that haying has a definite seasonal requirement in harvesting season and a steady day by day requirement in dairying, while potatoes have a requirement involving several peaks at planting, spraying, and harvesting. However, within limits these peaks of labor requirements do not conflict.

Diminishing Returns an Important Factor

On a given farm, as the operator applies additional units of labor and capital to the production of hay on a given acre, the net returns resulting from each additional unit at first increase and then decline. (Fig. 15.)

First, if we assume a definite acreage of hay in relation to available machinery, the operator soon reaches a point where additional labor in harvesting is not as productive as the preceding units of labor. The hay, for instance, is not made much more valuable, if at all, by frequent handling in the curing process. The records on the group of 38 farms indicate a range of from 3.1 to 12.2 hours per ton of hay harvested, which suggests that some of the operators put considerable additional labor on hay. There is no evidence in this study that the resulting output is more valuable. The operators who use more than 10 hours per ton are securing low returns for the last extra hour spent on hay harvested.

Second, if we assume an efficient ratio of labor per acre and a definite amount of available labor and equipment and add acres of hay, we become involved in lengthening the harvesting period, which in turn involves changes in yield per acre and in quality of hay on that

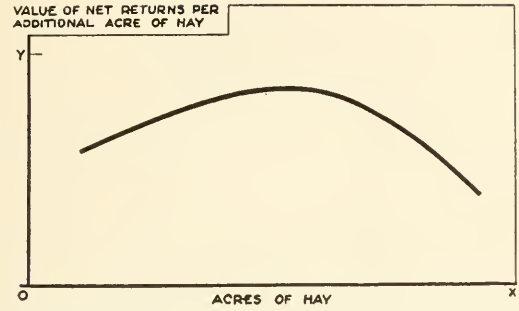

FIGURE 15. Point of diminishing returns for haying.

Beyond a certain point additional units of labor and capital expended on harvesting an acre of hay result in lower net returns for each successive unit applied. The labor on hay ranged from 5.2 to 24.7 hours per acre on individual farms. On each farm the combination of the crops and the detailed practices on each should be such that returns for the farm as a whole are maximized.

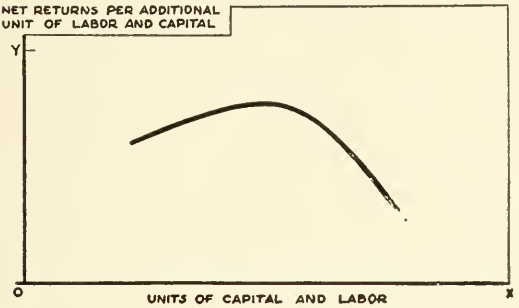

FIGURE 16. Favorable hay harvest season.

With reliance on available equipment and labor, the addition of acres of hay beyond a certain point extends the harvesting period into the season before or after the most favorable feed value period. Thus each additional acre beyond a certain point returns successively less than the preceding acres. This general situation applies to all crops.

portion of the crop which is harvested very early or very late. (Fig. 16.)

The total food value of hay increases gradually as the season advances and then declines as the grass becomes fibrous. The stage of highest value is comparatively short. The operator therefore should begin before the peak value stage and must by necessity continue haying after the decline in value has occurred. It was observed by the field man that some operators waited for maturity before beginning haying and that consequently the hay cured in the last of the season was very poor in quality. The important issue here is that as we add acres of one kind of hay beyond a certain point to the organization and thus extend the harvest season, the net return from the additional acres is successively diminished. In an extreme case the last acre added may be harvested so late as to return only half as much as hay harvested at the best time.

There is a double advantage in organizing the haying operations so that harvesting can be carried out efficiently and quickly on an acreage not excessive in relation to available labor and equipment. The effective use of labor in harvesting enables the operator to have more acres of hay and to harvest a larger proportion of it within the season when feed value per acre is highest.

Moreover, there is a change in the market value of the additional tonnage, as total yields are increased. On the dairy farm there is a premium on hay up to the point of meeting the requirements of the dairy cows and replacement heifers. The addition of acres of hay beyond the usual requirements of the herd may have less value per

ton than that from the preceding acres. There is a balance on the one hand in number of cows which the available labor can conveniently handle and on the other hand of the hay, roughage, and pasturage produced. Beyond this point hay can be utilized only in ways where returns may be less per ton. An individual farmer may sell hay to a neighbor who is short of feed, but for the area as a whole under present price relationships, local utilization of hay is the only practical alternative.

A similar situation involving diminishing returns from additional applications of labor and capital applies to the other possible activities on the farm, such as raising of replacements, potato production, lumber operations, and milk production. To simplify the problem, dairying and potatoes can be considered alone.

Under conditions of production in this area, including the handicaps of a very short season for field work, of small irregular fields, and of a sloping and rocky soil, the expansion of potato production beyond four or five acres will often require large readjustments of labor and the building of additional storage so that the net returns resulting from the last acre will be lower than from the preceding acres.

Similarly, as the operator adds cows to his organization, a point is reached where the net return resulting from the addition of each successive cow is less than for preceding cows. This may result from neglect of cows due to lack of available time or from hiring of additional labor made necessary by the increase in the herd.

By the very nature of the two enterprises, wholesale dairying and potatoes, the operator cannot use all his available resources exclusively on either one. In the process of expanding his available labor and capital on both enterprises the operator's problem is to distribute them so that the total net returns are maximized.

In figure 17 curves are drawn to illustrate the returns for successive applications of resources on milk and potato production. These curves are drawn freehand and without a definite statistical basis. In a generalized way, they represent the relative net income from successive additional applications of labor and capital on potatoes and dairying. It will be noted that when over half of the available resources have been used for dairy production, the returns from the last unit of resources spent on cows are less than from some units directed toward potato production. The line AF drawn horizontally across the diagram has been fitted so that the sum of the resources used in dairying (AB) and potato production (AC) does not exceed the total available resources (AF). At this level returns from the last unit of resources applied to dairying and from the last unit applied to potato production tend to be equal.

Combination of Four Enterprises

To simplify the discussion as much as possible, the emphasis so far has been on the combination of dairy and potatoes, but of course the real problem is the combination of dairy, potatoes, replacements and woodland products. In figure 18, curves have been drawn representing the net returns from the use of additional units of avail-

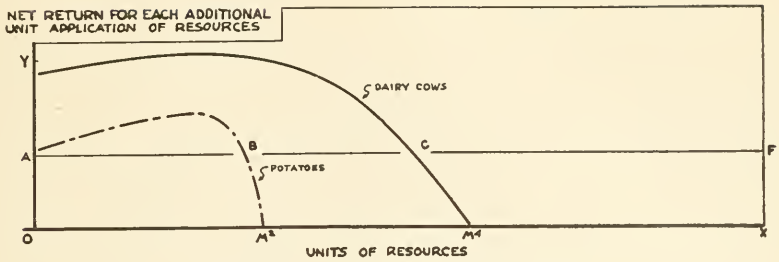

FIGURE 17. Proportion in enterprises.

The two curves in figure 17 indicate the net returns from additional applications of resources in the production of potatoes and milk. Since additional units applied to either enterprise beyond a certain point result in net returns successively less than for the preceding units, the best combination of the two enterprises is indicated where the horizontal line intersects the two curves. At these points the net returns from the last unit of resources applied to potatoes is the same as that resulting from the last unit applied to dairying. The sum of the resources used on dairy and potatoes (AB + AC) is approximately equal to the total resources (AF).

able resources on all four enterprises. These curves are not supported by detailed data but represent the situation in a general way. The diagram over-simplifies the problem and does not fully account for competing requirements for labor, for the use of different grades of land, and for the use of different proportions of labor and capital on the various enterprises.

The curve indicating returns on replacements is high at the beginning because if the replacements were not raised the operator would have to purchase approximately one heifer annually for each five cows in the herd. And, of course, if all of the farmers in the area followed a similar practice of not raising their own replacements, the value of heifers would be high. A deficit situation, other conditions being equal, will always result in higher values than a surplus situation. Production of replacements beyond the needs of local herds brings problems of salesmanship and of declining possibilities for selection and culling. A curve for a few of the farms which have high quality cattle and good opportunities for marketing would not decline as rapidly. Based on the situation now existing on most of the farms of the area, the curve would decline after the needs of the herd have been satisfied. Of course, the extent of this enterprise is limited by the number of heifers available.

The curve for woodland products in the area varies greatly on the various farms. A typical situation of low merchantable timber inventories is described in the curve in figure 18. A moderate return for fuel wood for home use and a declining curve beyond these requirements are indicated. Where merchantable timber resources are available, the curve would be higher all along the line.

While the returns per hour on woodland products under these conditions are not high, the available labor could not be applied to better advantage on the other enterprises because of diminishing returns.

It should be noted that these curves expressing the returns from successive applications of labor and capital to the various enterprises are influenced by seasonal crop requirements. For this reason the

returns from the units of labor and capital at the margin are likely to be rather low. In the winter when very little or no labor can be used to advantage on crops, the operator may well consider using his available labor and equipment on woodland management even if the returns for the last units applied are low.

Thus the farm operator with poor timber resources could get up his own fuel supplies by cutting weed trees. He might well continue using his available time on management and improvement problems even though results were not large. Two farmers with equivalent available labor in the winter but with widely different timber resources might each use all the available labor on the woodlands, one employing extensive methods on a good woodlot and obtaining good returns for labor and the other carrying out a more intensive management job on the poor timber resources available to him. This might result in quite different practices on adjoining woodlots and yet each operator would be combining his available labor and resources to the best advantage.

Analysis by Budgeting or Substitution

Of course, the curve as indicated in figures 17 and 18 cannot be drawn accurately because of insufficient data. But on the other hand, there is enough information to warrant drawing generalized curves. These at least illustrate the situation theoretically and indicate one reason why the usual money cost account data cannot be relied upon. Cost account records as usually determined express the average cost per unit. An intelligent decision as to the best combination of enterprises requires data concerning the last unit of inputs. The decision requires data at the margin (the point where the operator is undecided as to the application of additional expenditure of his available resources); the usual account records indicate the average cost. Then, too, because of joint costs and joint products, supplementary and complementary situations which exist on these dairy farms, the average cost of any one item such as milk or potatoes cannot be accurately determined. Since neither the marginal cost nor the average cost as usually determined by the cost

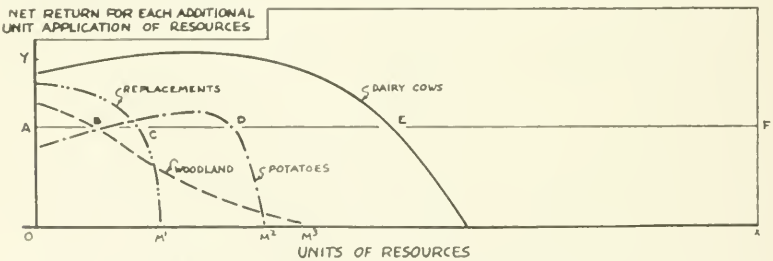

FIGURE 18. Proportioning four enterprises

The curves in figure 18 indicate the net returns from additional applications of resources in four enterprises, dairying, potatoes, replacements and woodland. The best combination of the four enterprises is indicated by the intersections of the horizontal line and the four curves. At these points the net returns for the last unit of resources used are the same for each enterprise. The sum of the resources used on the four enterprises (AB + AC + AD + AE) is approximately equal to the total available resources (AF). Note that the horizontal line in figure 18 is slightly higher than in figure 17.

account method are usable in actual practice in determining the best combination, and because the problem is so complex, one of the most satisfactory methods of analysis is to approximate the best combination. Then by a budgeting procedure the effect of changes in the enterprises can be tested. For this type of analysis considerable account data are greatly needed.

A typical one-man farm under present conditions in the area would have 10 cows, five head of young stock, two horses, 35 acres of hay, three acres of oats and two acres of potatoes. Based on normal prices and normal yields expected for the region, the financial situation would be approximately as follows:

Present Plan

Sales			
Crop of potatoes, 2 acres, 500 bu.		@ $ .60	$300
Milk sales, 10 cows, 45,000 lbs.		@ 2.00	900
Livestock, 2 old cows		@ 20.00	40
Work off the farm			40
Wood sold			30
Total sales			**$1310**
Cash expenses			
Taxes	$100		
Grain, feed	300		
Other materials, etc.	200		
Seed, spray, equipment	50		
Miscellaneous	100		
Hired labor	100		850

Net returns for land, capital and family labor, $460

Revised Plan

(Expanding potato acreage from 2 to 4 acres)

Sales			
Crop of potatoes, 4 acres, 1000 bu.		@ $ .60	$600
Milk sales, 10 cows, 45,000 lbs.		@ $2.00	$900
Livestock sales			40
Work off the farm			40
Wood sold			30
Total sales			**$1610**
Cash expenses			
Taxes	$100		
Grain, feed	300		
Other materials, etc.	200		
Additional fertilizer for hay land	30		
Seed, spray, equipment	100		
Miscellaneous	125		
Hired labor	175		1030

Net returns for land, capital and family labor, $580

An increase of potatoes from two to four acres would involve a reduction of two acres of hay. Substitution of potatoes for hay will in any one year result in the reduction of total yields of hay and this may mean curtailment of the dairy enterprise. However, on a long-

time basis there is evidence that the inclusion of potatoes in the rotation under the usual practice will result in increased yields of hay per acre. It is estimated that two acres of potatoes on a 40-acre farm will have no appreciable effect on total yields of hay provided they are grown on new ground each year in rotation and with usual applications of fertilizer. It is estimated that an acreage of potatoes in excess of 5 per cent of the tillage will result in progressive diminishing of the total yields of hay. In the revised budget plan the loss in hay acreage is offset by greater yield which would result from application of commercial fertilizer as a top-dressing on the remaining hay land.

Since the requirement for hay is approximately three tons per cow, the decline of each three tons of hay may result in the reduction of the size of the herd by one cow. Each ton would represent approximately a net income of $25 in dairy products. If the decline in total hay resulted in the reduction of young stock, each ton of hay would represent approximately $18. Thus the substitution of potatoes for hay would result in reduction of hay when the potato acreage was over five per cent of the total tillage. Each ton less of hay produced can be estimated to cause a net loss in milk or young stock income of from $15 to $25. This is ignoring the pasture situation and of course the reduction in size of the herd may mean better pasturage for the remaining cows.

A study of labor charts indicates that the operator on one or more farms could do most of the work on four acres of potates up to harvest with his available labor. This might require some adjustment in potato equipment. However, with present practices more than four or five acres of potatoes would require additional hired labor. Under these conditions an additional acre would probably not add to the net returns of the farm as a whole.

On a few of the farms where the fields are more easily tilled the operator could grow more acres of potatoes by using more efficient machine methods. This would require a shorter rotation to eliminate the witchgrass and other weeds that handicap production and would also require the use of modern one-man planters of the picker type, potato seed cutting machines, and better spray outfits.

On most one-man farms of the area because of the very short season for work in the fields, small amount of tillage land, and difficult land to operate, four acres of potatoes would fit into the organization very well under the usual methods of cultivation. On some farms, more adequate machinery and a short rotation would enable the operator to fit six or seven acres into his combination. Except in a few special instances, the addition of potato acreage beyond this point would not increase the net returns of the farm. Thus potato production in the region is distinctly a supplementary crop to wholesale dairying, although one operator has expanded production as a special enterprise to 35 acres. He uses a semi-abandoned farm which has good tillage land. He is well equipped with machinery and by a system of intensive production has reduced the weed handicap, and he has access to a special marketing outlet. The small

operator could not follow this program because it would limit his dairy enterprise and result in a lower net income.

The budget analysis on page 33 is based on an assumption of normal potato prices in the area, and probably would result in slightly greater total potato acreage. It is difficult to estimate the extent of increase because some of the operators are no longer in the prime of life and will tend to curtail potato acreage. Of course, if this area expanded potato production and thousands of similar areas did likewise on the same basis, the price of potatoes would be low, and the situation on the individual farms would call for a reduction in acreage. At this time the farmers seem to be restricted to this one cash crop, and it would seem sound to use their available labor on the combination of dairying, potatoes, and woodland on the basis of what they can normally expect from each enterprise. If the shifting of general cash crops results in expansion of production, the resulting lower prices may call for readjustment to demand.

The individual operator must adjust his organization on the basis of prices, but he should be fully aware of the regional and national trends.

A study of the labor requirements of the dairy enterprise, including the harvesting of hay and the distribution of manure on the land (Fig. 11, 12, 13, and 14) indicates unused available labor in the spring before haying and in the fall after haying. The same charts indicate that the requirements for potato production fit into these slack periods very well.

One two-man farm had 27 cows and grew one acre of potatoes (Fig. 11). A slack period resulted for both available labor and teams until July when hay harvest began. Under the conditions of rather high labor requirement per acre of potatoes, very little additional cash cost was required. The operator would in a normal year increase his income by about $130 by growing the one acre of potatoes. Both he and the regular hired man would do more work and have less free time at slack periods, but the income would be greater. He could add additional potato acreage without hiring more labor.

On another two-man farm (Fig. 13) with 19 cows, 40 acres of hay, 14 acres of small grain, and 10 acres of potatoes, the potato crop makes use of available labor in May and June and early fall. The extreme peak of labor requirement in early October required the employment of additional help. In this case the operator had expanded potato production to a point where the crop could be grown up to harvest without extra hired help.

A careful study of the many labor charts on the farms indicates that the one-man farm with 10 to 14 cows and four to eight head of young stock can produce four to five acres of potatoes under the usual management practices of the region without having much additional labor except at harvest, that a greater acreage than this is questionable because considerable additional hired help is required. On a few farms a larger acreage can be grown to advantage because the soil and topography are more advantageous for machine work than on the other farms.

Cropping plans

On Farm A with 56 acres of tillage land, the operator could maintain an organization of 18 to 20 cows and eight to ten head of young stock and four to five acres of potatoes.

In planning the use of tillage land, the potato crop would be given priority because it normally represents a high return per acre. But because the organization is basically a dairy farm, the potatoes would be incorporated into a rotation in which hay is an important crop. A four-year rotation on these dairy farms would involve approximately 20 acres for the potato-hay rotation fields.

The best land for potatoes on the farm is a 22 acre field which is a good loam and well drained. This could be laid out into four plots of 5.5 acres each. (Fig. 19). These areas, A, B, C, and D, would be rotated so that each field would have potatoes, oats, clover and hay each four-year period. These tillage fields would not be limed or if limed the application would be limited to small applications which would not raise the pH above five. With liberal application of complete fertilizer on the potato crop and an application of manure once in the rotation, the capacity of the land would be maintained and improved. The short rotation would control quack grass and lower the labor requirement on potatoes. After the system had

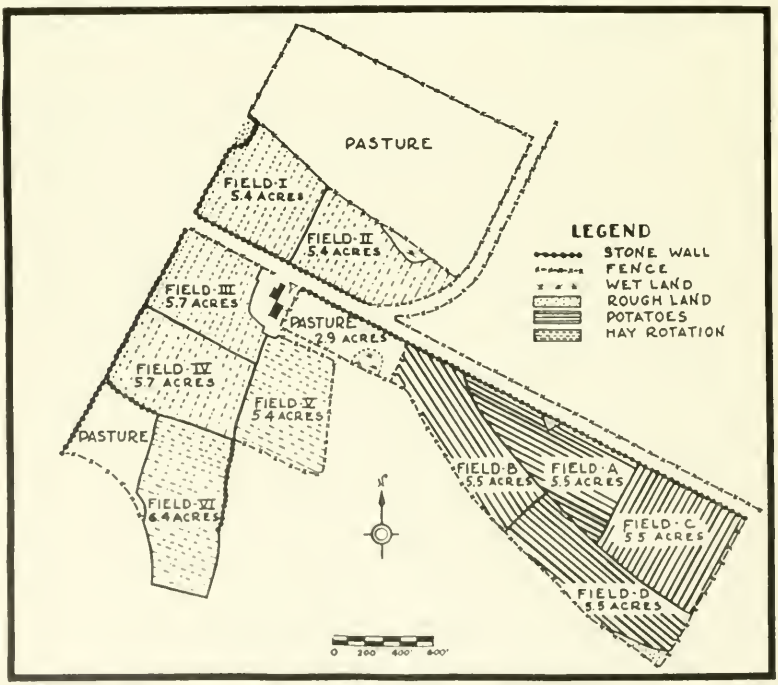

FIGURE 19. Cropping plan on a dairy farm with about five acres of potatoes each year.

been in operation a few years the yields, based on experience of farmers, would be approximately:

A.	Potatoes	5.5 acres @	300 =	1650	bushels	
B.	Oats	5.5 acres @	50 =	275	bushels	+ 8 tons straw
C.	Clover	5.5 acres @	2.5 =	13.7	tons	
D.	Hay	5.5 acres @	2 =	11	tons	

The remaining good tillage land would be divided into six fields of approximately equal size and one of these would be reseeded each year. Lime and manure and superphosphate would be applied in preparation for reseeding. The detail requirements of lime and fertilizer to carry the soil at the most profitable level of yields when the fields have been operated under this system for several years would depend on prices of fertilizers, the price of milk, and other factors. In the light of experiments conducted by the agronomy department, the approximate fertilization program could be worked out. In general, to maintain the capacity of the soil would probably require a ton of lime, 300 pounds of superphosphate, and 20 tons of manure per acre once in each rotation. The production from these plots should approximate:

Field 1	5.4 acres oats	50.	270 bushels
Field 2	5.4 acres clover	2.2	11.9 tons
Field 3	5.7 acres hay	2.	11.4 tons
Field 4	5.7 acres hay	1.8	10.3 tons
Field 5	5.4 acres hay	1.6	8.6 tons
Field 6	6.4 acres hay	1.4	9.0 tons

a total of 270 bushels of oats, 8 tons of straw, and 51.2 tons of hay. Combining both cropping systems there would be a total of 16 tons of straw, 545 bushels of oats, and 76 tons of hay. This is sufficient roughage for the 18 cows and 10 head of young stock and two horses.

The plan would require the plowing and fitting of about 16 acres of land each year. Approximately five tons of lime, 3000 pounds of acid phosphate, 200 pounds of grass seed, and 20 bushel of oats would be required in seeding down. The potato crop would require five tons of commercial potato fertilizer and 80 bushels of potato seed. The annual out-of-pocket cost of lime, fertilizer, and seed would approximate:

5 tons of lime	$ 30.00
3000 pounds acid phosphate	30.00
200 pounds seed	30.00
5 tons potato fertilizer	175.00
80 bushels seed	75.00
Total	$340.00

To maintain adequate pasturage for cows and young stock, approximately five additional tons of lime, 1500 pounds of superphosphate, and 1000 pounds of potash will be required each year. This will require an annual expenditure of about $50. Not including requirements of the potato crops, $140 will be needed for fertilizer, lime, and seed. Approximately one-fourth of this could be supplied by the AAA program. This is of course an aggressive management program using the available labor and purchased supplies of fertil-

izer on the tillage land and pasture to produce a larger part of the dairy herd feed requirements. The out-of-pocket costs for lime and fertilizer are larger than the amount normally expended in the past, but this is offset by a marked reduction in purchased grain. The farm is also on a conservation basis, improving rather than depreciating in capacity.

From the long-time point of view, such a conservation program seems essential if commercial agriculture is to continue in the region. When the gross returns from all crops are small due to low prices, it may be a hardship for the operator to purchase lime and fertilizer for the upkeep of his land even though such an investment seems necessary for the continuous maintenance of the farm. Since the investment in soil improvement is directed toward sustaining social as well as individual assets, the AAA program at present would carry part of the cost.

The program as outlined would eventually result in greater quantity and better quality roughage. This would enable the operator to substitute some roughage for present purchased grain and to carry two or three additional cows or additional young stock. This might result in little increase in production of milk, depending on the price. The tendency would be to withhold feeding of purchased grain when prices were low. However, if all the farms in the area increased cows and production, the total milk exported from the group of farms would be larger.

It should be noted that this is a concentrated dairy region and while total production may be slightly increased, other marginal areas in the same county are giving way to other uses. There can

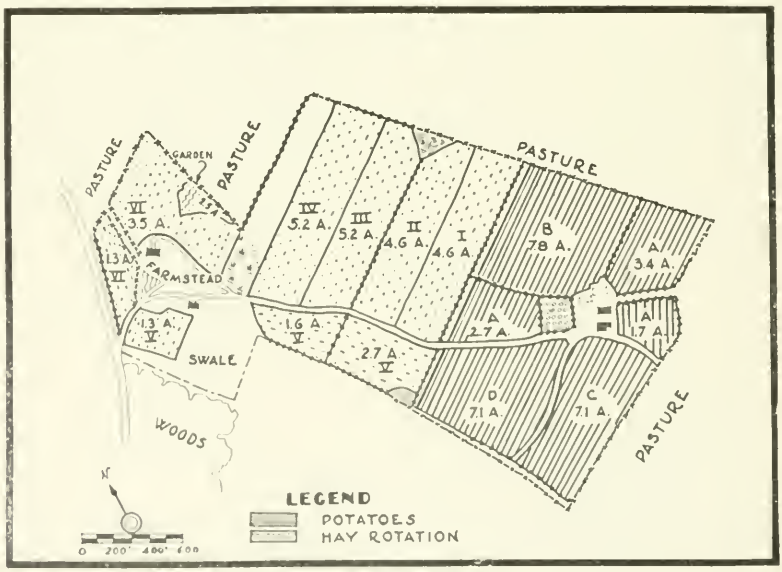

FIGURE 20. Cropping plan on a two-man dairy farm with over seven acres of potatoes each year.

be an increase in the more favored areas without an increase in the total. Moreover, due to ownership problems or topography restrictions on many farms in the Colebrook area, improvement programs will not be followed. An increase in production on some of the better farms will tend to offset reduction on others.

The possibility of increased production on the better farms due to improved cropping management is not inconsistent with long-time national policy, because total production of milk in the whole area may not be increased and because production costs are lowered by the improvements undertaken. The operators on marginal lands who do not make improvements are further handicapped by the improved practices of men on better land, and are less able to compete in the production of milk. If the results of improved practices were developed quickly, the difficulties of the marginal farmer would be intensified which would raise serious short-time adjustment problems.

The present organization on Farm B is 29 cows, 12 young stock, three work horses, 53 acres of hay, eight acres of oats and four acres

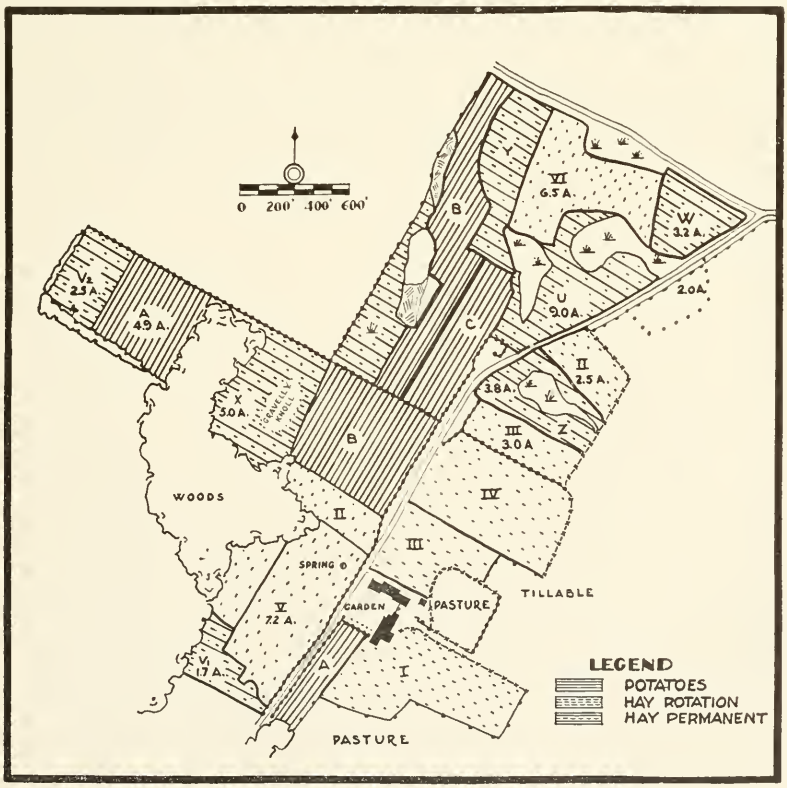

FIGURE 21. Cropping plan on a large dairy farm.

This involves two separate rotations, a four-year potato-hay and a six-year silage-hay rotation. Other fields are in permanent hay to be plowed and reseeded when necessary.

of potatoes. The present layout, as can be noted from the map, has resulted from the combination of two farms. (Fig. 20).

Fields on the upper farm are especially suitable for potatoes and so the tillage land is reserved for a four-year potato rotation—potatoes, oats, and two years of hay. A total of about 30 acres would make 7.4 acres available for potatoes each year. If less acreage in potatoes is desirable, the least favorable parts of the field can be sown to millet. The remaining good tillage land totaling 27 acres would be operated as a six-year rotation for hay production, one field being sown to oats and seeded down to clover and grass each year. Lime and superphosphate would be applied to fields in this rotation.

Farm C represents a more complicated situation, since the operator has over 90 acres of tillage and has been able to grow silage on some of the fields. (Fig. 21.) Twenty-six acres have been appropriated for a four-year potato-hay rotation system. Forty-two acres have been reserved for a six-year silage-hay rotation system and the remaining 22 acres of tillage land are used for permanent hay production. Some portion of this might be plowed occasionally and reseeded but much of it would be left productive by top-dressing. Some of it is wet or ledgy and difficult to plow. This plan reserves a limited acreage of the best tillage land for potatoes on which little or no lime would be applied. It incorporates the remaining good tillage land into a rotation including silage and attempts to carry the more difficult land with as little plowing as possible.

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